# Evaluation of Supraspinatus Muscle Composition and Mechanics Following Rotator Cuff Tear and Repair

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## Summary

Muscle compositional changes, including muscle atrophy and fatty infiltration, occur after rotator cuff tears (RCT) and are linked to altered shoulder function. The temporal progression of composition changes in muscle is unknown. Temporal changes in supraspinatus composition and muscle mechanics were identified after both RCT and surgical repair, suggesting a link between muscle composition and muscle function.

## Introduction

RCTs are known to cause muscle atrophy and fatty infiltration [1]. These composition changes lead to negative rotator cuff repair (RCR) outcomes and decreased shoulder function [2]. The structure-function relationship in the affected muscle post-RCT and how it changes temporally after RCT or RCR is unknown. Our objective was to define temporal changes in supraspinatus muscle composition after RCT and RCR and determine the link between composition and muscle function.

## Methods

New Zealand White rabbits (N=19; 7M/12F) were randomly assigned to 1 of 7 groups that determined duration in the study (IACUC #201800257). The 2- ,4-, 6-, 8-, and 16-week injury groups received RCTs by sharply dissecting the supraspinatus tendon [3]. The 8- and 16-week sham groups received sham injury surgery. At 8-weeks post-RCT, 16-week injury and 16-week sham groups received RCR or sham repair, respectively. Animals were euthanized at assigned timepoints, and shoulder and forelimbs were harvested for MRI. A modified 2-point Dixon scan (RARE) was used with a 7T Bruker MRI scanner (Bruker Biospin, Billerica, MA) to differentiate between muscle and fat [1,4,5]. Supraspinatus was manually segmented using Avizo (Thermo Fisher Scientific, Waltham, MA) to determine total volume. A custom MATLAB (The MathWorks, Inc, Natick, MA) script quantified fat volume, muscle volume, and fat percent from the segmentation. After MRI, supraspinatus was harvested for mechanical testing. A MTS 858 Bionix system (MTS Systems Corp., Eden Prairie, MN) and a prior protocol, including cyclic loading, stress-relaxation, and load-to-failure tests, was used[6]. Elastic modulus, stiffness, and yield strength were calculated. All outputs were normalized by rabbit body weight and standard deviations were calculated for groups with n≥3. Separate linear regression analyses were run to determine associations between compositional measures, mechanical properties, and body weight using SAS OnDemand (SAS Institute, Cary, NC) software, with significance set to $p<0.05$. Due to the small sample, qualitative assessments of temporal trends were done.

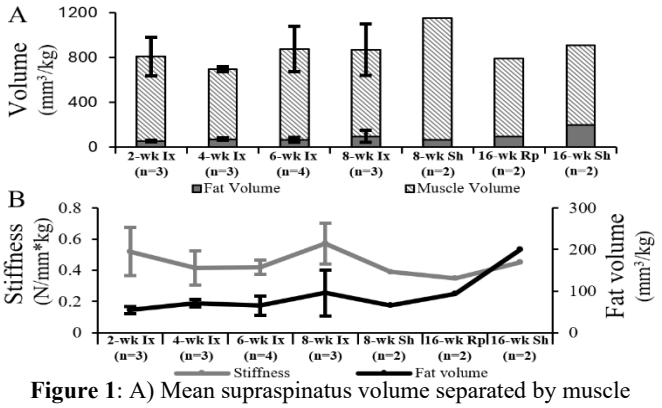


**Figure 1**: A) Mean supraspinatus volume separated by muscle and fat, and B) mean stiffness and fat volume across timepoints. wk=week; Ix=injury; Rp=repair; Sh=sham

## Results and Discussion

Fat volume increased over time after RCT. RCR did not reverse fatty infiltration (Figure 1A). Fat percent was associated with body weight ($p=0.0364$). Stiffness trended toward an association with fat volume ($p=0.0612$) (Figure 1B). Elastic modulus and yield strength followed the same trend as stiffness over time, where both decreased after RCT; only yield strength increased post-RCR. This work shows composition and mechanical property change and progress over time post-RCT, but do not all improve post-RCR. Combined composition and mechanical changes may negatively impact shoulder function. These preliminary results suggest a relationship between increased fatty infiltration and muscle function after RCT and RCR.

## Conclusions

Temporal changes in muscle composition and mechanics were identified post-RCT and post-RCR, suggesting an association between muscle structure and function. These findings are consistent with reported deficits in shoulder function after RCT. This work is a portion of a larger study that will continue to examine the temporal relationships between muscle structure and function after RCT and RCR.

## Acknowledgments

NIH R01AR079999; Penn State Animal Resource Program.

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